Sample Processor for Life on Icy Worlds (SPLIce)

Completed Technology Project (2016 - 2018)

Project Introduction

INTRODUCTION, GOALS AND OBJECTIVES We propose to develop, mature and integrate microfluidic sample-processing components and technologies into a platform to support life detection and habitability characterization of Encela-dus and Europa. Our goal is to enable and enhance spacecraft-based instrument performance by providing wet-chemical processing of samples obtained above, on, or beneath frozen surfaces of ocean worlds. Objectives include demonstrating the capability to accept and process the sorts of samples anticipated from ocean-world missions and to process them to meet the specific re-quirements of several instruments being developed for ocean-worlds missions. METHODOLOGY The Sample Processor for Life on Icy Worlds (SPLIce) will heavily leverage technology readi-ness level (TRL) 7-9 spaceflight-qualified/proven fluidic components from multiple nanosatellite payloads, as well as funded future missions to interplanetary space and Earth orbit. Thus, it will advance the TRL of a system composed of multiple existing technologies at various TRLs. Rele-vant demonstrated nanosatellite technologies include microfluidic design, development, fabrica-tion, integration, and test approaches, as well as stringent sterility and cleanliness protocols. The enabling components and technologies span TRL 3-5 in the context of a payload system to sup-port ocean-world exploration. SPLIce will be matured to an integrated system with an exit TRL of 5 and a demonstrable path to TRL 6 by preliminary design review for, e.g., a New Frontiers mission opportunity. SPLIce development will be guided by two key principles: (1) to be general and capable, inte-grating functions serving both common and disparate needs of multiple instruments; (2) to reduce analytical risk by delivering characterized, pre-processed sample aliquots according to each in-strument's input requirements. SPLIce functions include: sample retrieval from a collector; rea-gent, buffer and standard reconstitution and delivery; dilution; concentration; degassing/de-bubbling; removing interfering ions; adjusting pH or ionic strength; adding dyes/molecular labels to facilitate detection; filtering, capturing, staining of insoluble particles for microscopy; deliver-ing particle-free aliquots to instruments. To reduce risk and improve reliability while supporting multiple analytical instruments, SPLIce includes parallelism and redundancy: the sample is divided at the earliest logical stage following retrieval from the sample collector. Associated mass, volume, and complexity penalties are min-imal due to monolithic integration of fluidic features and components. NASA Ames Research Center (ARC) and our partners are uniquely suited to mature, augment, and develop SPLIce: ARC has extensive spaceflight heritage with integrated microfluidic archi-tectures and our team is well experienced with high-heritage instruments suited to life detection and habitability characterization. RELEVANCE SPLIce will significantly improve instrument performance and enhance certainty of results for ocean-worlds missions including potential future Discovery and New Frontiers opportunities. As described in the COLDTech announcement, SPLIce is a "sample distribution system capable of parsing and delivering samples to multiple instruments, and to one instrument multiple times, in order to reproduce results with the same,

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Concepts for Ocean Worlds Life Detection Technology

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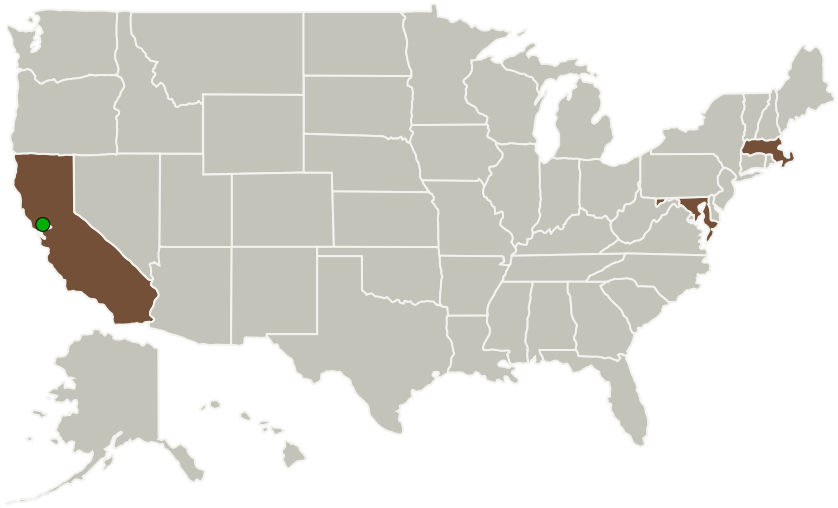
as well as different, instruments." Further, our project "focuses on advancing the technology readiness level of a system composed of multiple existing technologies at various TRLs." SPLIce directly addresses NASA, SMD, and COLDTech program goals: it focuses on ocean world flyby, orbital, and surface missions such as the Europa lander; it is suited for multiple pay-loads and implementations. The planned 2017 release of an Announcement of Opportunity for the New Frontiers Program mission investigations of ocean worlds, including the search for signs of extant life, is a key target.

Anticipated Benefits

This project will benefit NASA unfunded and planned missions to the Ocean Worlds, in particular those searching for extant life or its indicators in the oceans of Enceladus and Europa. Fluidic processing, the function of SPLIce, is key to sample preparation for the detection of biomarkers from liquid water (including melted ice) samples. With regard to specific mission concepts, these fluid handling systems would be an integral part of the payloads for a Europa lander or an Enceladus plume-sampling mission.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Project Management

Program Director:

Carolyn R Mercer

Program Manager:

Carolyn R Mercer

Principal Investigator:

Antonio J Ricco

Co-Investigators:

Linda R Timucin
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Mary N Parenteau
Nathan E Bramall
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Elena Adams
Andrew Pohorille
Robert E Gold
George Cooper
Richard C Quinn

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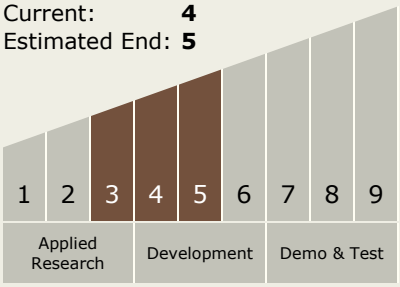
Primary U.S. Work Locations	
California	Maryland
Massachusetts	

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **5**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors
    - TX08.3.4 Environment Sensors

Target Destination

Others Inside the Solar System